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ac-dc power supplies

BEHLMAN-INVAR ELECTRONICS CORP.
1723 CLOVERFIELD BLVD.
SANTA MONICA, CALIF.

REPRESENTATIVES IN ALL PRINCIPAL CITIES AND CANADA

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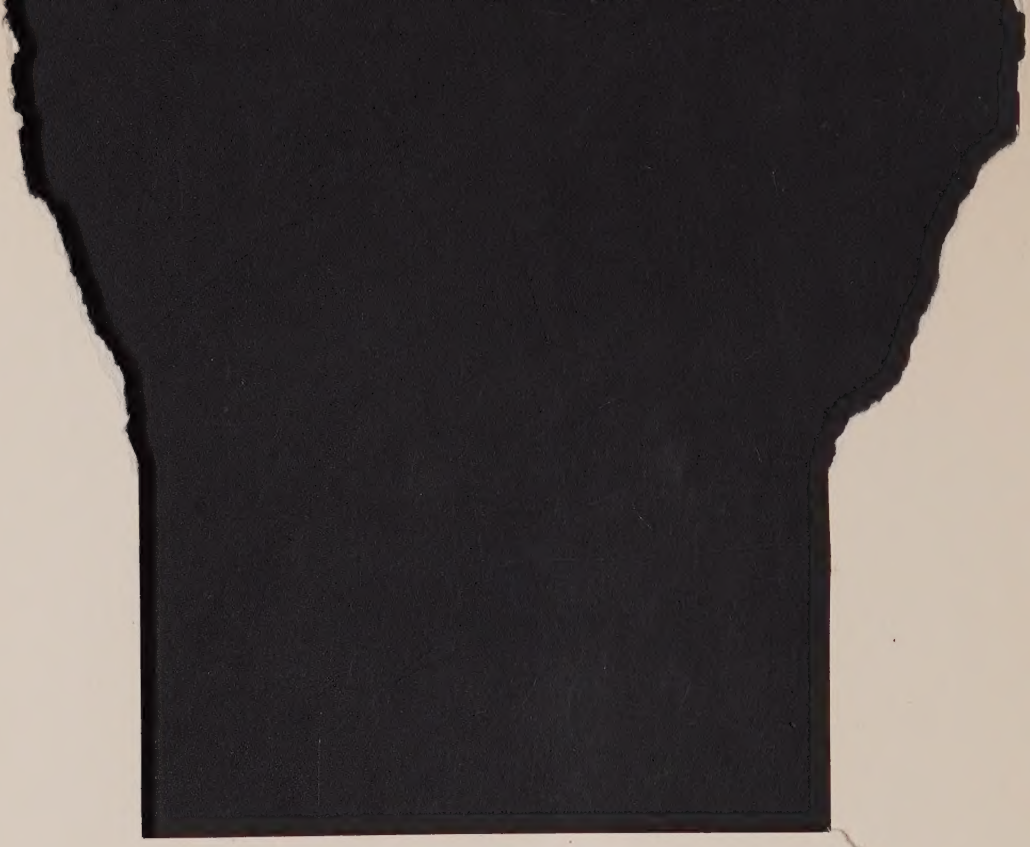

MANUAL
OPERATIONAL - MAINTENANCE

MODELS: TPA-36/18

Publication No. 1008

NOTICE:

The information contained herein is for the sole purpose of providing the data used in operating and maintaining the above-captioned power supplies and may not be used for any other purpose or reproduced in any form, either in whole or in part, without the written consent of Behlman-Invar Electronics Corp.

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SECTION I
INTRODUCTION AND DESCRIPTION

1-1. GENERAL.

Behlman-Invar Electronics Corporation, who have pioneered many of the more important advancements in the field of transistorized power supplies, are pleased to submit this instruction manual for the model TPA-36/18 Series power supply unit.

This model is a precision transistorized power supply which operates from 105/125 volts ac at 55/65 cps line voltage, and delivers a precisely regulated dc output that is variable for 0 to 18v at 3 amps or 0 to 36v at 1.5 amps. (See Paragraph 1-7, Electrical Specifications.) This unit may be used in the laboratory or incorporated in other electronic equipment as a source of high quality, fully regulated dc power. A front panel switch permits selection of either 0 to 18v or 0 to 36v operation. The unit may also be used as a series or parallel mode of operation. (See Figure A-1, Series/Parallel Connections.)

1-2. PURPOSE.

To provide a power supply under design criteria conforming to the latest state of the art.

To provide an operational and instruction manual containing complete information for assistance when using the units.

1-3. WARRANTY.

Seller warrants the end product of its design and construction to be free from defects in material and workmanship. Any component parts other than vacuum tubes, fuses, blower motors, indicating lamps and other indicating devices (except as warranties on these items are passed on to the seller by its suppliers) which become defective during the first year after shipment will be replaced free of charge by the seller, provided that the instrument is returned with transportation charges prepaid by the original purchaser and that our

examination discloses to our satisfaction that the instrument is defective, but if the apparatus is installed, or its installation supervised, by the seller, said year shall run from the completion of the installation, provided that same is not unreasonably delayed by the buyer.

The condition of any tests shall be mutually agreed upon, and the seller shall be notified, and may be represented at, all the tests that may be made. The liability of the seller to the buyer (except as to title) arising out of the supplying of the said apparatus, or its use, whether on warrant, contract, or otherwise, shall not in any case exceed the cost of correcting defects in the apparatus as herein provided, and upon the expiration of said year all such liability shall terminate.

The foregoing shall constitute the sole remedy of the buyer, and the sole liability of the seller.

1-4. PREPARATION FOR USE AND RESHIPMENT.

Unpack the instrument with care and inspect it for any damage which it may have incurred in transit. If there is any damage, or if the unit fails to operate properly in accordance to instructions (See Paragraph 2-7), a claim should be filed with the carrier, with a copy of the Claim Agent's report being forwarded to Behlman-Invar Electronics Corporation.

NOTE:
DO NOT RETURN THE INSTRUMENT
TO THE FACTORY WITHOUT PRIOR
AUTHORIZATION FROM BEHLMAN-
INVAR ELECTRONICS CORPORATION.

On packaging for reshipment use adequate shock-absorbent material within the carton to prevent the instrument's sharp corners from protruding which would result in unit damage.

1-5. QUALITY CONTROL AND INSPECTION.

Behlman-Invar Electronics Corporation functions under a company-wide quality assurance program which insures that our customer receives equipment manufactured to the most exacting standards. This quality assurance system is based on the best commercial practices augmented by policies and procedures required under MIL Q-9858.

1-6. SAFETY NOTES.

WARNING

Operation of the Behlman-Invar power supply involves the use of high voltage. Use EXTREME CAUTION when any internal adjustments or tests are being performed.

CAUTION

When remote sensing is not used VERIFY that the REMOTE SENSE shorting jumpers are correspondingly installed on the minus and plus remote sense terminals located on the chassis rear to avoid damaging the unit. (See Schematic, Figure A-1.)

1-7. ELECTRICAL SPECIFICATIONS.

The following tabulation lists the electrical characteristics for the TPA-36/18 Series power supply.

	Output dc		Regulation		Ripple	Output Z		Transients	
Model	E (v dc)	I (amps)	Line	No load to full load	mV rms max	ohms dc	ohms 100 kc	±10% Line	Recovery time no load to full load μsec. max.
TPA-36/18	0-18 0-36	3 1.5	10	5	0.3	0.003	0.2	None	50

TABLE 1-1.

Input Line Voltage: 105/125v ac at 55/65 cps, single phase.

Remote Sensing: Remote sensing is provided so that the selected output potential is maintained across a remote load despite a nominal line drop (due to their length) in the interconnecting cables.

Short Circuit Protection: Unit is capable of being shorted continuously without damage. Turning on the unit while the output or remote load is shorted causes no damage, and when the short is removed the voltage and current return to preset values.

1-8. ENVIRONMENTAL SPECIFICATIONS.

F1: Fuse, 2 amp, located on the front panel and inserted in the ac input to the supply.

Operating Temperature: 0° to 50° C.

1-9. MECHANICAL SPECIFICATIONS.

Width	Height	Depth	Weight
8-1/4"	5"	14"	17

TABLE 1-2

Mounting: The single or multiple units may be mounted on a standard 19" relay rack panel.

Terminals: Front and rear-mounted terminals are incorporated which provide ac input, dc output and remote sensing. (For functions see Schematic, Figure A-1.)

1-10. APPLICABLE DOCUMENTS.

Design Control: Behlman-Invar 008-0099.

SECTION II

PRINCIPLES OF OPERATION AND INSTRUCTION

2-1. DESIGN OBJECTIVE.

The design parameters of the Model TPA-36/18 Series power supply contribute to their operation in the following manner:

a. Provide a dc power supply fully regulated that is variable from 0 to 18v or 0 to 36v, as specified in the electrical specifications. (See Paragraph 1-7.)

b. Provide high efficiency operation by allowing only a minimum of internal wattage dissipation regardless of output load conditions.

c. Provide fully rectified, filtered and stabilized voltage for the regulation circuitry, transformer section, filter section, and Zener diode section.

d. Provide a remote sensing function, permitting the output voltage to be regulated from the voltage sensed at the load end. This feature ensures that the output voltage at the load remains constant, within the regulation specifications, with a nominal line drop.

e. Provide multiple operation when desired of either series or parallel mode (see Figure A-1, Multiple Operation Connections Diagram).

2-2. CIRCUIT THEORY OF OPERATION.

Input ac is supplied from J1, Pins 1 and 2, through S1, Blower, and DS1, Indicator Light, to the primary of T1, where the ac is then supplied from one-half of the secondary of T1 to the raw dc section of the supply. Depending

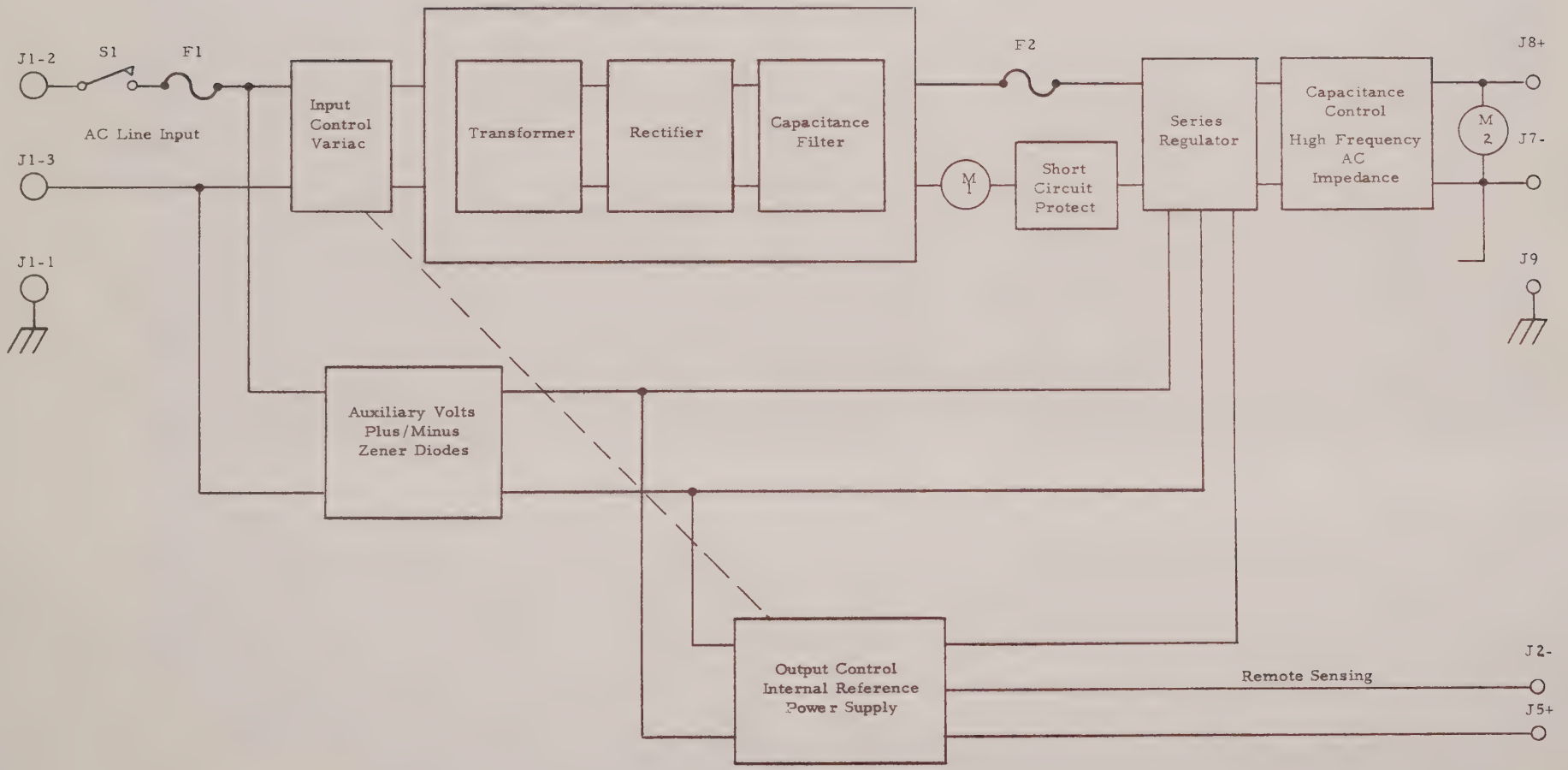


FIGURE 2-1. TP SERIES FUNCTIONAL BLOCK DIAGRAM

upon selection by S2 of either 0-36v, or 0-18v operation, this step-down ac is then applied to diodesCR1 and CR2, respectively, from where it is filtered by C1.

The raw dc is then applied to the series regulator pass transistors Q10-1, Q10-2 and Q10-3, whose bases are driven by the power driver Q9 and the small signal driver Q8, whose bases are in turn being driven by the balanced amplifiers Q6 and Q7.

The power supply output voltage is sensed at the base of Q7 and compared with a very stable reference voltage developed across R20 and R21, the output adjust voltage control.

2-3. INTERNAL REFERENCE SUPPLY.

The internal reference supply section, consisting in part of the transistors Q2, Q3, Q4 and Q5, and Zener reference diode CR9, is essentially in itself a small regulated dc supply, whose purpose is to furnish a highly regulated comparison voltage to the base of Q6.

2-4. AUXILIARY SUPPLY.

Raw dc being furnished to the internal reference supply (see Paragraph 2-3) is obtained from the secondary #2 of T1 and applied to rectifiers CR3 through CR6, then passing through the filtering network of R1, R2, C2 and C3. Zener diode CR7 furnishes the plus output voltage and C2 furnishes the minus output voltage for the auxiliary supply.

2-5. SHORT CIRCUIT PROTECTION.

The maximum output current adjust section and short circuit protection consist of Transistor Q1 and resistor network R11 through R14-2.

A reference voltage of approximately one volt is established at the emitter of Q1 by the diode CR8 and the dropping resistors R3 and R6. As the

current increases through the resistor network a voltage drop occurs which is tied to the base of Q1 through the resistor R10. As this voltage reaches and exceeds the emitter reference voltages, Q1 is turned on. The collector of Q1 is tied through R5 to the base of the small signal driver Q8, thus when Q1 is turned on Q8's base is grounded and current decreases.

In order to obtain the current cutback feature of our short circuit protection the reference voltages of the emitter of Q1 is lowered as the output voltage drops in short circuit and requires less current through R14 to maintain cut-off in the pass transistor.

2-6. CONTROLS.

a. R20, Output Voltage Adjust, ganged mechanically with R3, located on the front panel.

b. S2, Output Voltage Range, for selecting 0-18v or 0-36v dc, located on the front panel.

c. J1, Power Input Jones Plug, located on the rear of the chassis.

d. S1, Toggle Switch for ac line input, located on the front panel.

e. DS1, Amber "AC ON" Indicator Light, located on the front panel.

f. M1, 0 to 3 ammeter, located on the front panel.

g. M2, 0 to 40v dc Voltmeter, located on the front panel.

h. Plus/Minus dc Output, chassis ground, also plus/minus remote sense terminals. (For function see Schematic, Figure A-2.)

i. Plus/Minus dc Output Terminals and Chassis Ground, located on the front panel. (For function see Schematic, Figure A-2.)

2-7. OPERATIONAL PROCEDURES.

a.	CONNECT:	AC line to J1.
b.	SELECT:	0 to 18v or 0 to 36v operation with range switch S2.
c.	ACTIVATE:	S1 to the "ON" position.
d.	MONITOR:	DS1 for "ON" indication.
e.	ADJUST:	Output adjust voltage control for the desired voltage.
f.	MONITOR:	M1 and M2 for the desired readings.

2-8. REMOTE PROGRAMMING.

Turn the voltage adjust clockwise to maximum on the front panel. In remote programming the internal electronic protection is disconnected. It is advisable to use an external fast blow fuse in series with the load. A short circuit without an external fuse could damage the series regulator transistor. The remote programming control should be a 2K, 2W wirewound potentiometer connected as shown. (See Figure A-1, Multiple Operation Connection Data.)

SECTION III

MAINTENANCE AND TROUBLE SHOOTING

3-1. MAINTENANCE.

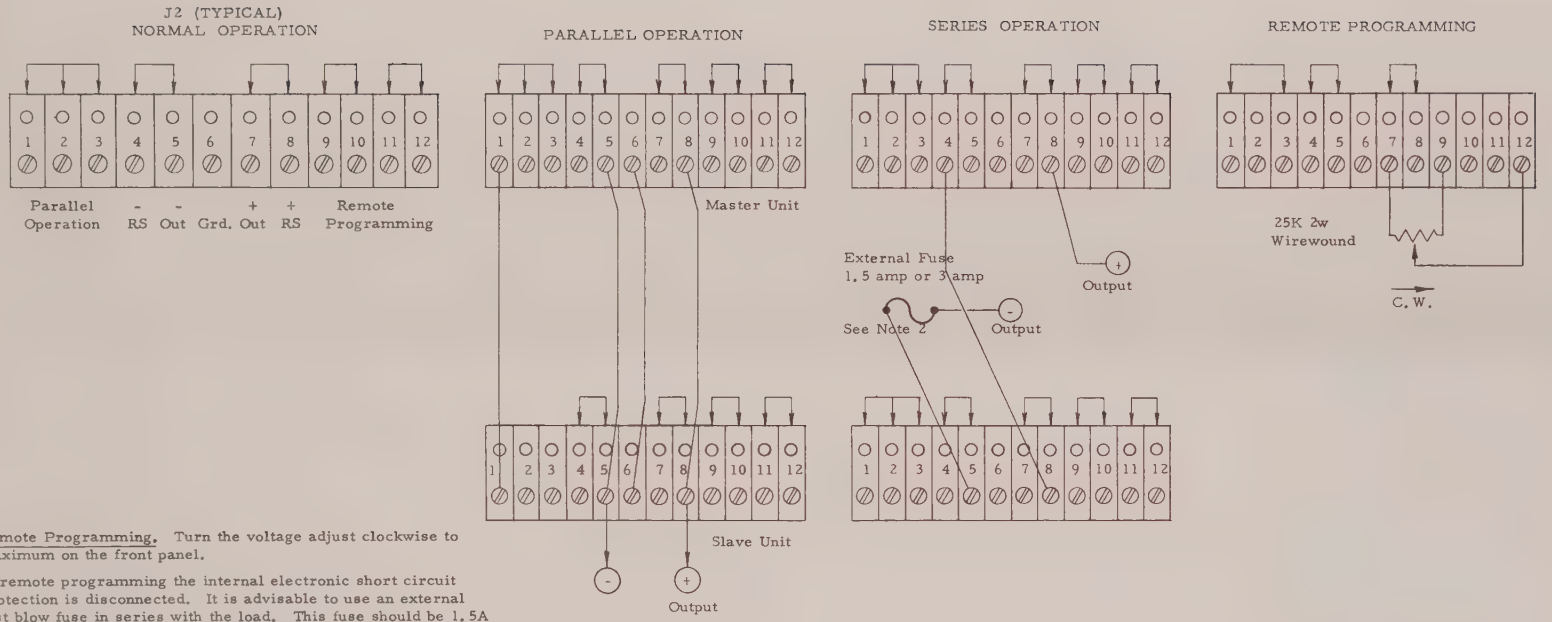
The supply does not require any periodic maintenance other than cleaning to remove excessive dust and dirt. The blower motor should be oiled occasionally. If it is necessary to replace components, use only first quality commercial components. No selected components are used. When replacing components or trouble shooting, observe "Warning" (see Paragraph 1-6), since dangerous voltages may exist in the power supply.

3-2. TROUBLE SHOOTING PROCEDURE.

a.	SYMPTOM:	No output voltage.
	CAUSE:	Fuse blown.
	REPAIR PROCEDURE:	Check for damaged rectifiers, CR1 through CR6, or shorted input capacitors, or transformer, before replacing ac fuse.
b.	SYMPTOM:	Poor regulation and output cannot be reduced to zero by output voltage control.
	CAUSE:	One or all of the series regulating transistors, Q10-1, Q10-2, or Q10-3, on the heatsink, or Q9 on the board, is shorted.
	REPAIR PROCEDURE:	Replace transistor.
c.	SYMPTOM:	Output voltage is high, also no regulation.
	CAUSE:	One or more of the jumpers on the rear terminal strip are not connected or are improperly connected.

REPAIR PROCEDURE: See instructions and schematic for proper jumper connections. (Refer to Figure A-2, Schematic.)

APPENDIX



3. Remote Programming. Turn the voltage adjust clockwise to maximum on the front panel.

   In remote programming the internal electronic short circuit protection is disconnected. It is advisable to use an external fast blow fuse in series with the load. This fuse should be 1.5A when the range switch is in the 36v position and 3A when in the 18v position. A short circuit without an external fuse could damage the series regulator transistor.

2. Series Operation. In series operation the internal electronic short circuit protection could fail. It is advisable to use an external fast blow fuse in series with the load. This fuse should be 1.5A when the range switch is in the 36v position, and 3A when in the 18v position. A short circuit without an external fuse could damage the series regulator transistors.

1. Parallel Operation. Turn the voltage adjust clockwise to maximum on slave unit.

FIGURE A-1

Date	Approved by:	TPA MODEL 36/18 MULTIPLE OPERATION CONNECTION DATA
	Prepared by:	

BEHLMAN ELECTRONICS CORP.
SANTA MONICA CALIFORNIA.

REVISIONS					
SYM.	ZONE		BY	DATE	APP.
L		CHANGED PER E.O. NO. 76	F.J.L.	2-2-61	
M		REMOVED 'A' IN DWG NO.	F.L.	5-4-61	
N		CHANGED PER E.O. NO. 136	F.L.	5-12-61	
P		CHANGED PER E.O. NO. 205	F.L.	7-5-61	
R		CHANGED PER E.C.O. NO. 465	BLV.	12-19-61	
S		CHANGED PER E.C.O. 421 & 616	ALEX	4-23-62	

T1
S2 CR1 20J3
S2 CR2 20J3
C1 3000µF 75V
S1"B"
R4 1Ω 5W
R3 500Ω 25W
R35 10Ω
DS1 NE51-H
FAN
F1 2AMP
S1"A"
J1
AC INPUT 115V 60~
R1 300Ω 3W
CR3-CR6 5C-4
C2 250µF 150V
C3 250µF 150V
CR7 1M47Z
R2 7K 3W
R5 330Ω
R7 200Ω 3W
Q3 2N1542
Q2 2N652
R8 100K
R9 150K
Q1 2N652
R10 100Ω
CR8 F4
R6 40Ω 3W
S2
R11 18Ω
R12 27Ω
R13 20Ω
R14-1 1Ω 5W
R14-2 1Ω 5W
M1 0-3 AMP
R15 33K
R16 5K 3W
C9 .002µF 400V
Q4 2N652
Q5 2N652
R17 1K 3W
R18 4.7K
CR9 1N2622
R19 2.5K 3W
C4 20µF 150V
R20 2K 2W MAXIMUM VOLTAGE ADJUST
R21 2K 2W OUTPUT ADJUST
Q10-1 2N1542
Q10-2 2N1542
Q10-3 2N1542
R34-1 .3Ω 2W
R34-2 .3Ω 2W
R34-3 .3Ω 2W
Q9 2N1542
R27-1 10K 3W
R27-2 10K 3W
Q8 2N652
R28 39K
R29 220K
R22 1K
R23 3K 3W
CR10 1N2622
R24 10K
R25 15K
Q6 2N652
C6 .04µF 200V
Q7 2N652
C7 20µF 50V
S2
R30 1.2K 3W
R31 500Ω 3W
R32 500Ω 3W
C5 100µF 12V
R26 33K
R33 330K
M2 0-40 VOLTS
C8 5000µF 50V
J2
PARALLEL OPERATION
REMOTE SENSING (−)
OUTPUT
J4 (−)OUTPUT
J3 (+)OUTPUT
REMOTE PROGRAMING
OUTPUT (+) REMOTE SENSING
GRD
J5 GRD

DRAWING NO. 008 0099
SHEET 1 OF 1
REV. S

5. THIS SCHEMATIC APPLIES TO SERIES 008A0099-L.
4. R3 & R21 ARE MECHANICALLY LINKED.
3. ALL RESISTORS 1/2 WATT ± 10%.
2. S2 SHOWN IN 36V POSITION.
1. THIS DWG SUPPLIED FOR THE OPERATION & MAINTENANCE OF INVAR EQUIPMENT AND IS NOT TO BE OTHERWISE USED OR REPRODUCED WITHOUT THE WRITTEN CONSENT OF THE INVAR ELECTRONICS CORP.

NOTES: UNLESS OTHEWISE SPECIFIED

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DESIGN			
ENGINEER M. McCarroll	1-3-61		
APPROVED		SCALE NONE DWG SIZE D	CODE SHEET 1 OF 1

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